

Lecture 5 - Nutrient Elements; Scavenged Elements - Questions and Answers

(1) Samples from the Atlantic and Pacific were collected for Zinc and Cerium. Unfortunately, the over worked graduate student (or was it the absent minded Professor?) forgot to label the station #'s. Can you help the student before any one finds out???? How can the student determine from which ocean the samples are?

The data are: Which ocean did these samples come from?

Zn		Ce	
I	II	I	II
0.8	0.8	66	19
1.6	8.2	11	6

Zn is a recycled element low in surface waters higher in deep Pacific. Ce is scavenged high at surface lower at depth higher in Atlantic waters

(2) Scavenged elements

- (a) Have a short residence time therefore they are uniformly mixed throughout the ocean
- (b) Always are enriched in the surface and depleted at depth
- (c) Have higher concentrations in the Atlantic relative to the Pacific
- (d) Have distributions that reflect their source
- (e) Non of the above

Phosphate is rapidly cycled in the upper ocean:

- (a) and its concentration is greater in the upper 1000m of the water column
- (b) and its concentration is less in the upper 300m of the water column than deeper
- (c) P is not rapidly cycled at all, it is slowly cycled by geochemical processes
- (d) P has the same concentration regardless of depth

Reactive or scavenged elements in the ocean:

- o are very reactive, and thus have a long residence time in the ocean.
- o include trace metals Al and Pb.
- o typically have highest concentrations in the Atlantic ocean and lowest in the Pacific.
- o are recycled many times in the surface ocean.
- o are NOT controlled by salinity variations in the ocean.

Nutrient-type elements in the ocean:

- o are very reactive, and thus have a short residence time in the ocean.
- o include trace metals Cd and Zn.

- o typically have higher concentrations in the deep Pacific ocean compared to the deep Atlantic.
- o are controlled primarily by salinity variations in the ocean.

Lignin is

- o unique to woody plants and therefore an unambiguous biomarker for terrestrial plants
- o a component of the organic carbon pool
- o a degradation product of chlorophyll and therefore an excellent biomarker for plant material
- o a primary part of the dissolved organic carbon pool in seawater which was never been properly measured until the late 1980's.

Ba depth profiles in the ocean follow those of Silica, Ba is a recycled element but it is not bio-limiting, accordingly we would expect Ba profiles to be:

- o depleted in the surface as much as the silica profiles
- o will not be enriched in the deep Pacific compared to the deep Atlantic
- o Ba concentrations in surface water to be less depleted than those of phosphate
- o the Ba maximum concentration to occur at the same depth as the nitrate maximum
- o the Ba maximum concentration to occur at the same depth as Si

Would you expect the nutrient content in surface water off the coast of California to be:

- higher than those in the deep Atlantic
- lower than those in the central Pacific surface water
- increase along a transect away from the coast
- lower than those in the deep Pacific
- higher than those of surface waters in the Sargasso sea

(3) Could you suggest why profiles of nitrate and phosphate reach maxima at shallower depth than silica?

These “soft part” nutrients are regenerated faster than silica and at shallower depths where maximum bacteria degradation occurs

(4) How would you expect the Ge profile to look like? What can you say about the behavior of methyl-Ge.

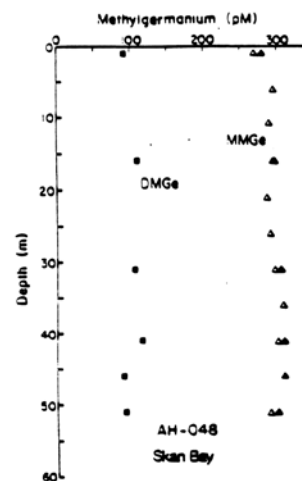


Fig. 3 Vertical profiles of monomethylgermanium (MMGe) and dimethylgermanium (DMGe) in Skan Bay. Open symbols, samples stored in polyethylene; solid symbols, those in sealed glass.

Like Si (below Si in the periodic table. Seems like MM-Ge is conservative

(5) Why are some elements, such as Zn or Si, greatly enriched in deep waters of the North Pacific relative to the deep North Atlantic, while other elements, such as Al and Pb, are greatly depleted?

The elements enriched are recycled their concentration increase as seawater ages more organic matter degrades thus higher concentrations in deep Pacific are expected. Al and Pb are scavenged their source is atmospheric input and they get adsorbed on particles at they fall down the water column.

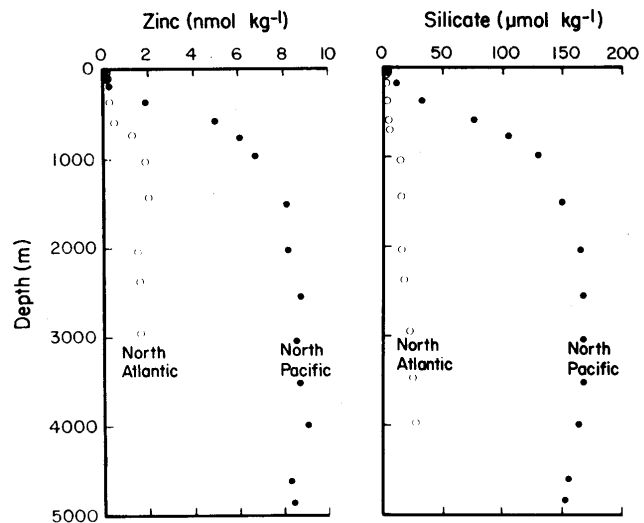


Fig. 45.6. Vertical profiles of zinc in the North Pacific and North Atlantic, from Bruland (1980) and Bruland and Franks (1983). Profiles of silicate are also shown for comparison.

(6) Draw a depth profile of PO₄, Cd, Si, Ba, and Pb in the Atlantic and Pacific.

Explain the sources and reasons for variation in the profile.

Pick two of these elements one with a large and one with a short residence time. What can you say about the relative reactivity for each one of these elements? What process(es) controls the residence time of each element?

PO₄, Cd, and bio-limiting shallow regeneration

Si bio limiting deep regeneration

Ba bio intermediate deep regeneration all the above have higher deep Pacific concentrations

Pb is a scavenged element concentrations higher in surface water and in the Atlantic.

The main source of all but Pb is river input for Pb it is atmospheric. Pb has short residence time and P high. Residence time is controlled by reactivity and input fluxes.

(7) All marine organisms got extinct and now we have a dead ocean! What would you expect the distributions of PO₄, temp, O₂, Co and Ar with depth and in the different basins to look like?

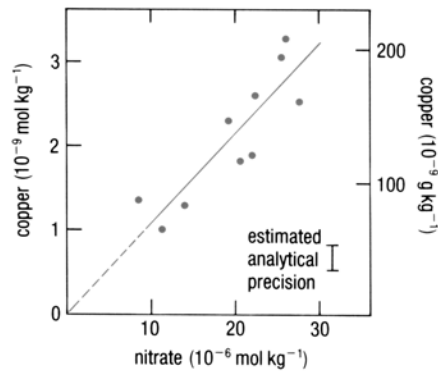
Gases in equilibrium with atmosphere and nutrients like conservative elements.

(8) The concentrations of *iron* in the ocean have only recently been reliably determined. Iron is clearly a nutrient-like element and it is believed to limit the rate of photosynthesis in nutrient-rich surface waters at the Equator and High latitudes. Deep concentrations however do not follow the behavior of a “nutrient-like” element. Can you give a suggestion to the processes that might control this behavior of Fe in the ocean?

Both recycling and scavenging

(9) In most parts of the ocean copper is defined as exhibiting bio-intermediate behavior. How does the figure suggest that copper might be bio-limiting micro-nutrient?

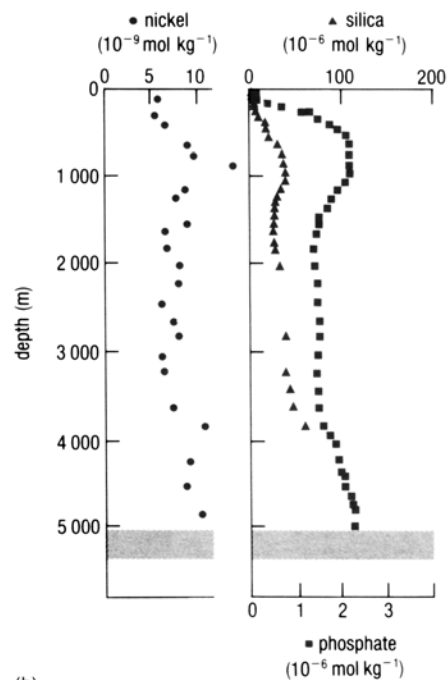
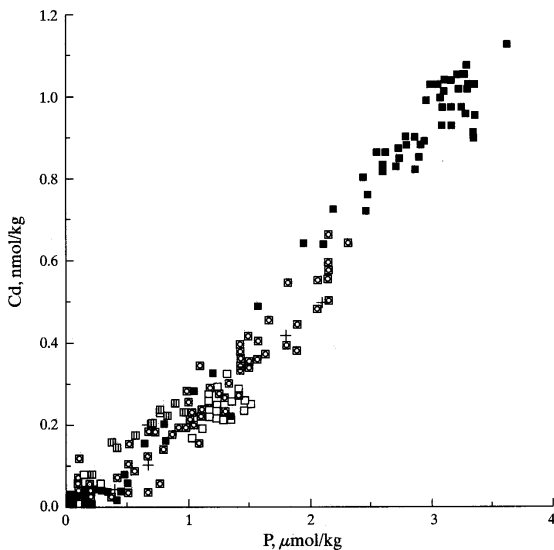
Concentration drops down to zero when nitrate is zero.



(a)

How is it possible to infer from the figure on the right that nickel distribution may be biologically controlled?

Follows Si



(b)

(10) From this figure above how would you define Cd distribution?

There is no known biological function for Cd or nickel can you suggest why they follow a nutrient type behavior?

Cd is a nutrient like element, they are taken up by organisms by mistake nor they have high affinity to particulate matter thus

(11) Can you say any thing about the sources of Al to seawater and its residence time?

Atmosphere and sediment resuspension
Short residence time

(12) Mn is a scavenged element with an important hydrothermal source but also a river sources can you predict the Mn distribution in the deep Pacific? Do you expect Atlantic and Pacific profiles to be similar? How?

Maximum above vents in some aspects like decrease with depth but the Atlantic will have higher concentrations at surface and the Pacific at depth.

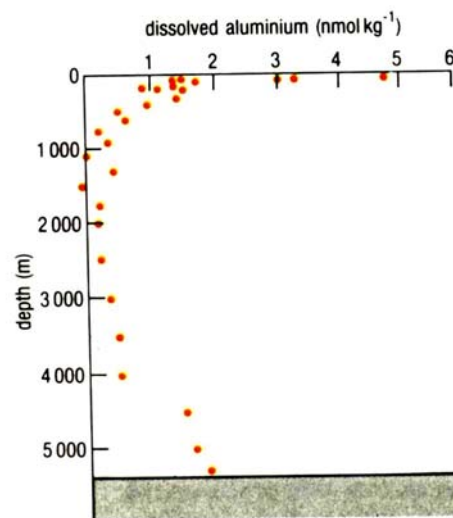


Figure 2.11 Concentration–depth profile for dissolved aluminium in the central North Pacific (28°15'N, 155°07'W). The increase in concentration at the bottom of the profile may be due to re-solution in deep water and/or to diffusion from sediment pore waters (see Chapter 5). (nmol = nanomol = 10⁻⁹ mole, and nmol⁻¹ ≈ nmolkg⁻¹.)

(13) After the Chernobyl nuclear accident short-lived radionuclides of ruthenium and cerium (Ru, Ce) with half-lives of weeks were detected at depth of 200 m or more in the Mediterranean and North Sea? Can you explain this?

These are scavenged they got adsorbed on particles and sank right down